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An innovative bioelectrochemical-anaerobic digestion-coupled system for in-situ ammonia recovery and biogas enhancement: process performance and microbial ecology

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Abstract

Ammonia (NH_4^+/NH_3) inhibition during anaerobic digestion process is one of the most frequent problems existing in biogas plants, resulting in unstable process and reduced biogas production. In this study, we developed a novel hybrid system, consisted of a submersed microbial resource recovery cell (SMRC) and a continuous stirred tank reactor (CSTR), to prevent ammonia toxicity during anaerobic digestion by in-situ ammonia recovery and electricity production. In batch experiment, the ammonia concentration in the CSTR decreased from 6 to 0.7 g-N/L with an average recovery rate of 0.18 g-N/L(CSTR)/d. Meanwhile, a maximum power density of 0.71±0.5 W/m^2 was produced (10 Ω). Both current driven NH_4^+ migration and free NH_3 diffusion were identified as the mechanisms responsible for the ammonia transportation. With an increase in initial ammonia concentration and a decrease in external resistance, the SMRC performance was enhanced. In addition, the coexistence of other cations in CSTR or cathode had no negative effect on the ammonia transportation. In continuous reactor operation, 112% extra biogas production was achieved due to ammonia recovery. High-throughput molecular sequencing analysis showed an impact of ammonia recovery on the microbial community composition in the integrated system. Results clearly indicate the great potential of the SMRC-CSTR-coupled system for efficient and cost-effective ammonia recovery, energy production and treatment of ammonia-rich residues.

Poster presentation